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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 3 (12): 2106-2108, 2000

Life Table Studies of *Trichogrammatoidea bactrae*, Hymenoptera: Trichogrammatidae, an Effective Biological Agent of Pink Bollworm (Pectinophora Gossypiella Lepidoptera: Gelechidae) of Cotton (*Gossypium* spp.)

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Abstract: Selected laboratory life table studies of *Trichgrammatoidea bactrae* were made at New Mexico State University, USA. Life history studies were run at 13, 18, 23 and 28°C at a constant 55% relative humidity (RH) and a 11/13 (light/dark) photoperiod. Speed of development from egg to the adult stage ranged from 50.31 to 8.72 days at temperatures from 13 to 28°C respectively. Immature mortality was highest (32.01 %) at 28°C and lowest (16.79 %) at 18°C. More females than males were found at all temperatures. Female fecundity related directly to temperature. There were 24 eggs per female at 28°C and 12 eggs per female at 13°C. Females lived longer than males at all temperatures. Net reproductive rate was maximum at 23°C (10.629) and minimum at 13°C (4.751). In trinsic rate of increase and finite rate of increase were maximum at 28°C (0.231 and 1.261 respectively) and minimum at 13°C (0.029 and 1.030 respectively).

Key words: *Trichogrammatoidea bactrae*, parasitoid, life table, speed of development, mortality, fecundity, net reproductive rate, intrinsic rate of increase, finite rate of increase, total time for a generation, Balochistan

Introduction

T. bactrae is widely distributed in the orient (India, Pakistan, China, Malaysia, Taiwan and Indonesia). It is adapted to terrestrial humid habitats and is known to attack various pests of cotton, sugarcane, fruits and vegetables (Nagaraja, 1978). There is a need to understand its life history and behavior in detail.

Nagaraja (1978) first described *T. bactrae* as, "Male body length 0.4 mm to 0.5 mm and width 0.15 mm to 0.18 mm. Head and antenna fulvous, eyes (ocelli) carmine. Pro and mesothorax fulvous black. Legs fulvous, mid and hind femora smoky. Abdomen black. Antenna flagellum with 22 to 26 long hairs, club segmented. Wings with setae, vein track Rs1 absent. Genitalia narrow, length three times to width. Female body length 0.42 mm to 0.5 mm and width 0.15 mm to 0.18 mm. Color same as in male. Antennal flagellum 1:2 times the length of the scape. Pedicel half of the scape, club width slightly less than half of the wing length. Wing with seata. Ovipositor as long as hind tibia and 0.33 times its length".

Hutchison *et al.* (1990) observed that *T. bactrae* completes its immature stages within the host egg (Pink bollwarm, *Pectinophora gossypiella*, PBW) taking about 10 days from egg to emergence at 24°C. An inverse relation was found between temperature and speed of development. Blackening of the vitelline membrane of the host egg during the pre-pupal stage of the parasitoid was observed. There were more males than females. Between 15 to 30°C, 51.6 to 77.5% females were observed in the cultures. Females lived longer than males. Males lived a maximum of one day at all temperatures. Immature mortality ranged from 10.6 to 73.0% between 15 and 32.5°C.

The objective of this research was to find a suitable environmental combination of temperature, relative humidity and photoperiod for the rearing of *T. bactrae* in the laboratory to establish it's population in the fields of cotton as a biological agent of PBW in IPM cotton program. Since *T. bactrae* is known as an effective egg parasitoid in Asia for a number of lepidopterous pests (Hutchison *et al.*, 1990).

Materials and Methods

This experiment was run in the Post Graduate's Laboratory, Department of Entomology, Plant Pathology and Weed Science, New Mexico State University, USA. To determine speed of development, mortality, sex ratio, pre-oviposition period and fecundity of the parasitoids at four different temperatures (13, 18, 23, 28°C) at a constant 55% RH and 11/13 photo periods, environmental chambers (Atmar and Ellington, 1972) were used. PBW eggs were imported from the Agricultural Research Service, Cotton Research Laboratory, USDA, Phoenix, Arizona and *T. bactrae* Pupae from the University of California, Riverside and then the colonies were established locally in the department.

To determine development and mortality, two hundred PBW eggs were placed in an air tight petri dish (50 x 9 mm) with ten pairs of *T. bactrae* with diet. After parasitization, the PBW eggs were placed in another air tight petri dish at the same temperature for emergence. Soon after emergence, ten males and ten females *T. bactrae* were placed in air tight petri dishes with two hundred fresh PBW eggs and diet. This procedure was replicated eight times. Development was noted twice daily. Because egg and larval stages could not be distinguished therefore these two stages were combined for data collection. Blackening of the vitelline membrane of the host egg occurs at the onset of the pre-pupal stage (Hutchison *et al.*, 1990). Therefore, the time from adult release to blacking was considered to be the egg/larval stage while blacking of host egg to emergence of the parasitoid was considered to be the pupal stage. After the emergence of all adults the speed of development of males and females was recorded.

To determine the pre-oviposition period, fresh host eggs (more than 500) were placed in a 50 x 9 mm air tight petri dish with three male and three female *T. bactrae* adults and diet. Pink bollworm eggs were replaced every hour for 12

hours. This procedure was replicated 8 times. The pre-oviposition period was found for 13 and 18°C but eggs were not found at 23 and 28°C suggesting that the pre-oviposition period for 23 and 28°C was less than one hour. To determine the pre-oviposition period at 23 and 28°C the PBW eggs were replaced every 15 minutes for one hour.

To determine the fecundity of female *T. bactrae*, more than 500 PBW host eggs were placed in a 50 x 9 mm air tight petri dish with three male and female *T. bactrae* and diet. Pink bollworm eggs were replaced every 12 hours until the death of the last female. This treatment was replicated eight times at each selected temperature. After the death of all the females, the total number of parasitized eggs were counted in each replication.

To compare biotic potential under the conditions of the experiment. Net reproductive rates (*Ro*), intrinsic rate of increase (*rm*), finite rate of increase (ë) and total time for a generation (*T*), were calculated with a computer program called Life-48 by Abou-setta (1986).

Statistical analysis: Treatments were replicated eight times for four generations in a split plot design. Data were analyzed by Statistical Analysis System (SAS) statistical procedures program (SAS Institute, 1990). ANOVA was used to test for significant differences between variables. Each temperature regime was considered a treatment and each small air tight petri dish a replication, egg/larval, pupal, male and female speed of development, egg/larval and pupal mortalities, fecundity, net reproductive rates, intrinsic rate of increase, finite rate of increase and total time for a generation of the parasitoids were the different variables in this experiment. Least Significance Difference (LSD) Test was used for means separation.

Results and Discussion

Mortality, Development and Male/Female Longevity: Temperature significantly influenced the mortality and fecundity of all development stages (egg/larval, pupal and adult male and female emergence) of *T. bactrae* (Table 1). Total immature mortality was highest at 28°C (32.01%). Total immature mortality decreased as temperature was decreased to 13°C. The lowest percent mortality occurred at 18°C (16.79%). The lower and upper threshold temperatures for *T. bactrae* appears to be below 13°C and above 28°C. Temperatures between 13 and 28°C appeared to be optimum temperatures for the parasitoid. As temperatures went towards lower or upper threshold levels the mortality increased.

Temperature also had an inverse effect on the mean development time of the parasitoid (Table 1). It took *T. bactrae* a minimum 8.72 days for the eggs to emergence at 28°C and a maximum of 50.31 days at 13°C. Although significant differences were found between all four tested temperatures (13, 18, 23 and 28°C) there was not much difference between 23 and 28°C. There were much larger differences between 13 and 18°C. It took less time for the pupal stage to develop than the egg/larval stage.

Females lived longer than males (Table 1). Both male and female longevity increased as temperature decreased.

Sex Ratio, Pre-oviposition Period and Fecundity: The *T. bactrae* Female/male ratio ranged from 58/42 to 63/37 (Table 1). The pre-oviposition period was only ½ hour at 23 and 28°C and 3 and 2 hours at 13 and 18°C respectively. The pre-oviposition period at 23 and 28°C was the same. The number of eggs laid per female decreased as temperature decreased. Maximum oviposition occurred at 28°C (23.50). Significant Female/male ratio and fecundity differences occurred at all four tested temperatures. Female *T. bactrae* laid 12, 15, 22 and 24 eggs at 13, 18, 23 and 28°C respectively. It was observed that occasionally *T. bactrae* laid more than one egg in a single host egg but either only one or none egg matured.

Life Table Parameters: Biotic potential has also direct relation with temperature (Table 2). Net reproductive rate was maximum (10.629) at 23°C. Intrinsic rate of increase and finite rate of increase were maximum at 28°C (0.231 and 1.261 respectively).

Based on these results, the speed of development of *T. bactrae*, from sting to adult death, was 11.03 and 9.98 days at 23 and 28°C, which is about the same as reported by Hutchison *et al.* (1990) 12.05 and 8.1 days at 22.5°C and 27.5°C, respectively and Naranjo (1993) 11.1 and 7.3 days at 22.5°C and 29.5°C respectively. Immature mortality was 16 to 32% at 18 and 28°C. Hutchison *et al.* (1990) got 11 and 34.3 % at 22.5 and 27.5°C and Naranjo (1993) observed 38% at 29.5°C. Hutchison *et al.* (1990) and Naranjo (1993) stated that females at any temperature lived longer than males. The Female/male ratio ranged from 58/42 to 63/37. Hutchison *et al.* (1990) got a Female/male ratio of 64/36 and 63/37 at 27.5 and 22.5°C. We obtained a maximum of 24 eggs/female at 28°C. Hutchison *et al.* (1990) got 19 and Naranjo (1993) 34 eggs per female at 27.5°C. Their differences might be due to differences in diet, relative humidity or density of parasitoids. Hutchison *et al.* (1990) and Naranjo (1993) used 10% honey solution while I used water dipped sponges filled with pure natural honey. I could not use diluted honey because diluted honey reduces the osmotic concentration and allows mold growth. Relative humidities were also different in these studies from the studies of Hutchison *et al.* (1990) and Naranjo (1993). They used 75% RH while I used 55% RH. Naranjo (1993) also reported that the density of parasitoids can affect oviposition. Higher densities (one female per host egg) resulted in super parasitism. Overall emergence averaged from 1.3 to 1.4 adults per host egg. Hutchison *et al.* (1990) used 1:10, Naranjo (1993) 1:25 and I used one female per 20 PBW eggs. Net reproductive rate at 23 and 28°C was 10.62 and 10.05 while Naranjo (1993) got 26.93 and 16.23 at 20 and 27.5°C. Intrinsic rate of increase was 0.214 and 0.231 at 23 and 28°C while Naranjo (1993) got 0.23 and 0.31 at 20 and 27.5°C.

Hutchison *et al.* (1990) worked on *T. bactrae* with emphasis on embryology while Naranjo (1993) emphasized life table parameters at high temperatures. Objective of this experiment was to determine a suitable temperature and humidity for laboratory rearing and field release. New Mexico is a cool dry state like Balochistan in which average annual rainfall is 17.5 cm and extreme summer temperatures rarely exceed 40°C. Hutchison *et al.* (1990) and Naranjo (1993) used high relative humidity (75%) to simulate Arizona conditions. Our temperatures of 13 to 28°C with 55% RH simulate New Mexico conditions. From these results, 23°C is the best temperature, among other

Table 1: [*1]Mean egg/larval and pupal speed of development, % immature mortality, male/female longevity, sex ratio, preoviposition period and fecundity of *T. bactrae* at different temperatures

Temp. °C	EGG/Larval Stage (days)	Pupal) Stage) (days)	[*2]Total Time From Egg To Emmer -gence (days)	Egg/Larval Mortality (%ag)	Pupal Mortality (%ag)	[*3]Total I- -mmature Mortality	Male Longevity (%ag)	Female Longevity (days)	Female/ Male Ratio	[*4]Pre-Oviposition Period (hours)	Fecundity/ Female (no.)
13	27.43a[*5]	23.00a	50.31a	21.44a	8.53c	29.97b	2.53b	5.92a	58/42d	3	11.6d
18	21.30b	19.16b	40.44b	8.45d	8.34c	16.79d	2.91a	5.64b	59/41c	2	15.01c
23	5.89c	4.00c	9.89c	10.35c	11.31b	21.66c	1.18c	3.00d	60/40b	½	22.5b
28	4.99d	3.73d	8.72d	13.64b	18.37a	32.01a	1.34c	3.53c	63/37a	½	23.5a

[*1]Means are from four replications. [*2]Total time from egg to adult emergence is the sum of egg/larval and pupal stages. [*3]Total Immature Mortality is the sum of Egg/Larval and Pupal Mortalities. [*4]Data for pre-oviposition period were not analyzed because there were no difference through out the eight replications thus it does not had LSD values. [*5]Lower case letters indicate significant difference down the column using the LSD test.

LSD for egg/larval stage 0.175, pupal stage 0.182, total immature stage 0.193, egg/larval mortality 0.345, pupal mortality 0.592, total immature mortality 0.468, male longevity 0.232, female longivity 0.22, female/male ratio 0.537 and fecundity/ female 0.413 at significance level of 0.05.

Table 2: Life table parameters of *T. bactrae* at various temperatures

Temperature°C	Net Reproductive Rate (Ro)	Intrinsic Rate of Increase (rm)	Finite Rate of Increase (ë)	Total Generation Time (T)
13	4.751 d*[1]	0.029 d	1.030 d	52.401 a
18	7.511 c	0.048 c	1.049 c	41.939 b
23	10.629 a	0.214 b	1.238 b	11.036 c
28	10.055 b	0.231 a	1.261 a	9.966 d

[*1]Lower case letters indicate significant difference down the column using the LSD test.

LSD values for *Ro*, *rm*, *ë* and *T* were 0564, 0.005, 0.007 and 0.863 respectively at significance level of 0.05.

three tested temperatures, for the rearing of *T. bactrae* in the laboratory with 55% RH and 11/13 photoperiod. This environmental combination allows the parasitoid to produce 33 generations in a year.

References

Atmar, J. W. and J. J. Ellington, 1972. Construction and control characteristics of environmental simulation chambers. J. Econ. Entomol., 65: 401-404.

Abou-Setta, M. M., 1986. Life-48 computer program to calculate life table parameters for an insect or mite species. Florida Entomol., 69:690-96.

Girault, A. A., 1912. Australian Hymenoptera Chalcidoidae, Memoirs of Queensland Museum, Anthony James Cumming Brisbane, pp: 66-189.

Nagaraja, H., 1978. Studies on *Trichogrammatoidea* (Hymenoptera: Trichogrammatidae). Oriental Insects, 2: 489-530.

Naranjo, S. E., 1993. Life history of *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae) an egg parasitoid of Pink bollworm (Lepidoptera: Gelechiidae), with emphasis on performance at high temperatures. Environ. Entomol., 22: 1051-1059.

Hutchison, W. D., M. Moratorio and J. M. Martin, 1990. Morphology and biology of *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae), imported from Australia as a parasitoid of pink bollworm (Lepidoptera: Gelechiidae) Eggs. Ann. Entomol. Soc. Am., 83: 46-54.

SAS Institute Inc., 1990. SAS User Guide: Statistics, Cary, North Carolina: SAS Institute Inc., USA.